Eastern South Dakota Soil and Water Research Farm

1995

Annual Report to the Board of Directors

March 20, 1996

USDA, ARS, Brookings SD
USDA, ARS, Morris MN
South Dakota State University

Annual Report

Eastern South Dakota Soil and Water Research Farm

Volume 7, March 1996

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Dr. Sharon Clay, Assoc. Professor, Plant Science
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History of the Eastern South Dakota Soil and Water Research Farm

The Eastern South Dakota Soil and Water Research Farm, Inc. is a non-profit organization consisting of a Board of Directors elected from each of 15 Soil and Water Conservation Districts in eastern South Dakota: Brookings, Codington, Clark, Day, Deuel, Hamlin, Kingsbury, Lake, Lincoln, Marshall, McCook, Minnehaha, Minor, Moody, and Turner. The purpose of the corporation is to promote research of efficient farm production practices that conserve soil and water resources.

The corporation bought 100 acres of land in Lake County, South Dakota, near the community of Madison in 1959. This land was leased to the Agricultural Research Service, United States Department of Agriculture. The work performed at the Madison farm included evaluation of the erosion of different soil types, development of tillage practices to conserve soil and water; determination of efficient crop production methods; and modeling plant-insect interactions. Research was conducted by scientists from the North Central Soil and Water Conservation Laboratory, ARS, Morris, MN; the Northern Grain Insects Research Laboratory, ARS, Brookings, SD; and the South Dakota Agricultural Experiment Station.

The Board of Directors decided to relocate the research farm closer to the research laboratories to improve program efficiency and facilitate productive cooperative research programs that would more effectively solve some of the problems that are associated with agriculture in eastern South Dakota. The Madison research farm was sold in 1987, and the Corporation bought another tract of land in Brookings County.

The Brookings research farm consists of 80 acres located approximately one mile north of the campus of South Dakota State University. The soils found on this farm are characteristic of those found in northeastern South Dakota and west central Minnesota and are similar to soils common to the northern corn belt.

1995 CROP REPORT

Max Pravecek
USDA, ARS Northern Grain Insects Research Laboratory

A wet spring delayed planting and forced some field experiments to be canceled for the 1995 growing season. A wet fall delayed harvest and prohibited most fall tillage. Rainfall amounts for the season, April through October, was 24.01 inches - 5.22 inches above normal.

Field day was held September 7. Approximately 100 people including Eastern South Dakota Soil and Water Research Farm Directors, congressional aides, scientists, and members of the public, attended. A mild evening with little wind and no rain and a roast hog supper catered by Blue Mound made the event a success.

Crop yields for the year were down slightly. The following tables show yield for all crops and statistical differences in inputs and rotations.

1995 Mean Corn Yield
Bushel/Acre

Input	Continuous Corn	Corn/Soybean	Corn/Soybean on Ridges	4 Year Rotation	Mean Input Yield
High	98.0 a,x	114.0 a,y	114.2 a,y	119.1 a,y	111.4
Intermediate	56.9 b,x	89.5 b,y	72.0 b,z	83.6 b,y	75.5
Low	0.0 c,x	0.0 c,x	0.0 c,x	71.6 b,y	17.9
Rotation Mean Yield	51.6	76.9	62.1	91.5	

1995 Mean Soybean Yield
Bushel/Acre

Input	Soybean/Corn	Soybean/Corn on Ridges	4 Year Rotation	Mean Input Yield
High	35.2 a,x	33.4 a,x	38.4 a,x	35.6
Intermediate	29.9 b,x	22.5 b,y	31.0 b,x	27.8
Low	26.5 b,x	25.9 b,x	25.2 c,x	25.8
Rotation Mean Yield	30.5	27.2	31.5	

1995 Mean Wheat Yield
Bushel/Acre

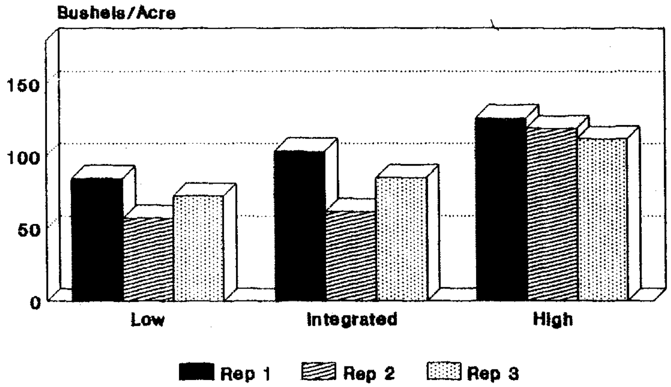
Input	4 Year Rotation
High	43.7 a
Intermediate	18.5 b
Low	18.7 b

1995 Mean Alfalfa Yield
Tons/Acre

Input	4 Year Rotation
High	3.3 a
Intermediate	2.9 a
Low	2.5 b

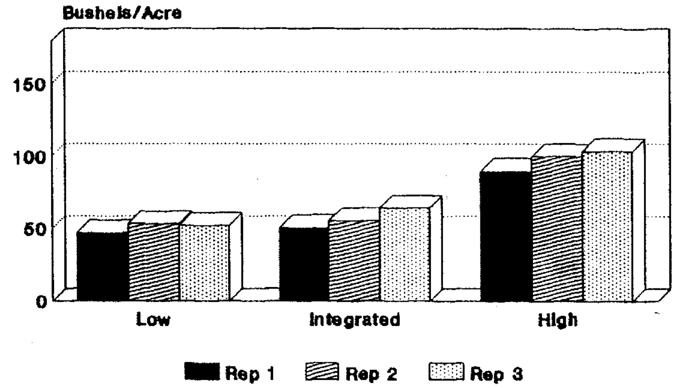
Means in columns followed by a, b, or c are significantly different at $P = 0.05$
Means in rows followed by x, y, or z are significantly different at $P = 0.05$
4 Year Rotation is corn/soybean/wheat/alfalfa cropping system

1995 Corn Yield
4 Year Rotation



USDA Research Farm

1995 Corn Yield
Corn Soybean Rotation



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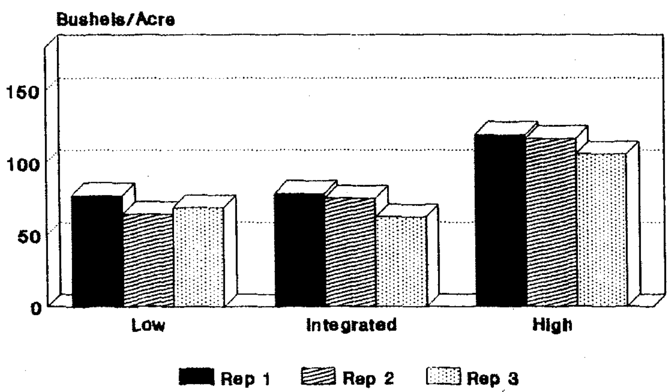
1995 Corn Yield
Corn Soybean Rotation on Ridges



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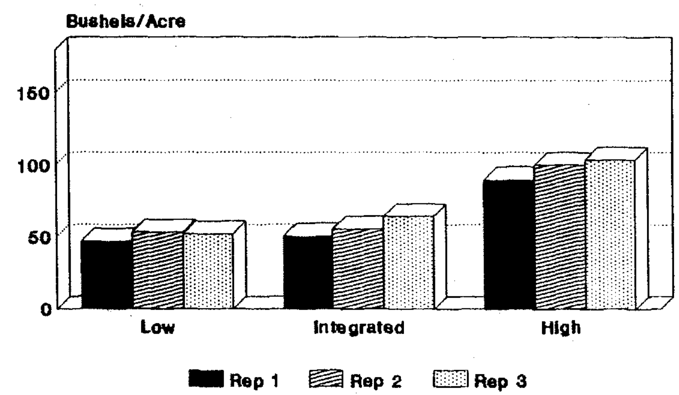
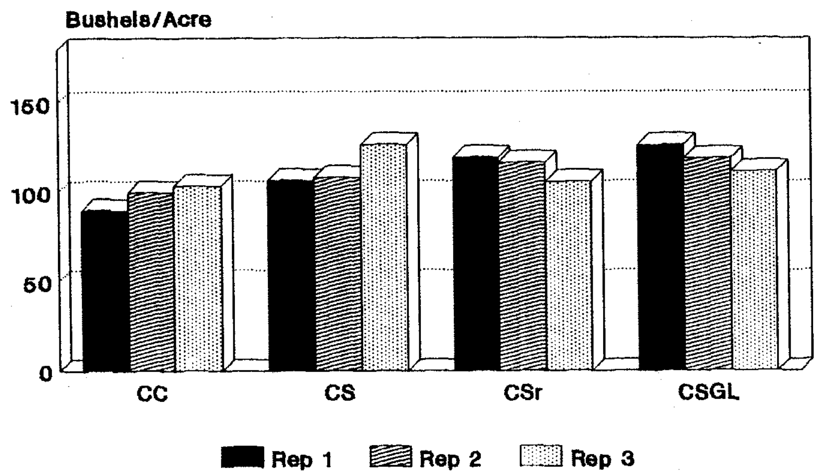
1995 Corn Yield
Continuous Corn



USDA Research Farm

1995 Corn Yield
High Input



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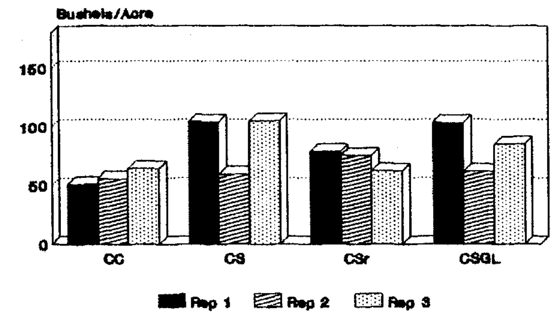
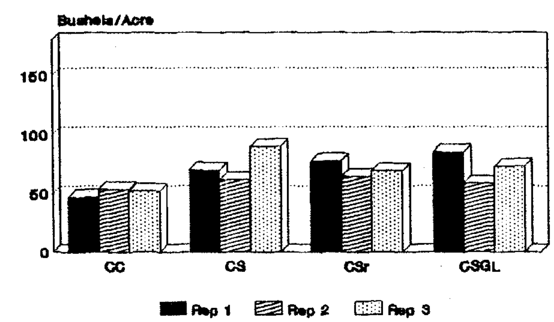
1995 Corn Yield
Integrated Input



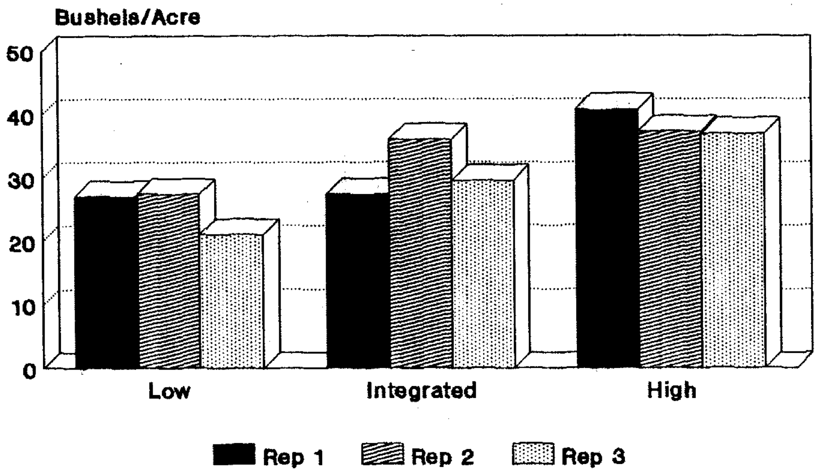
USDA Research Farm

1995 Corn Yield
Low Input (with Herb except CSGL)



USDA Research Farm

1995 Soybean Yield
4 Year Rotation



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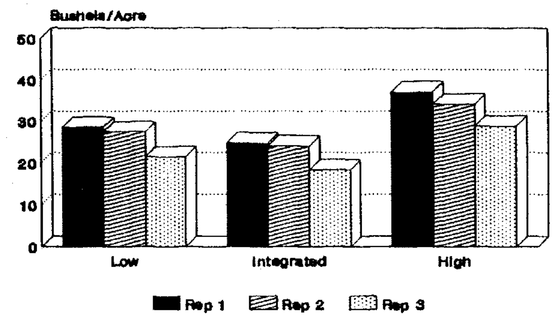
1995 Soybean Yield
Corn Soybean Rotation on Ridges



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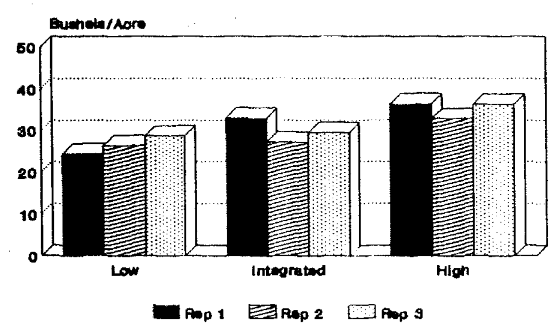
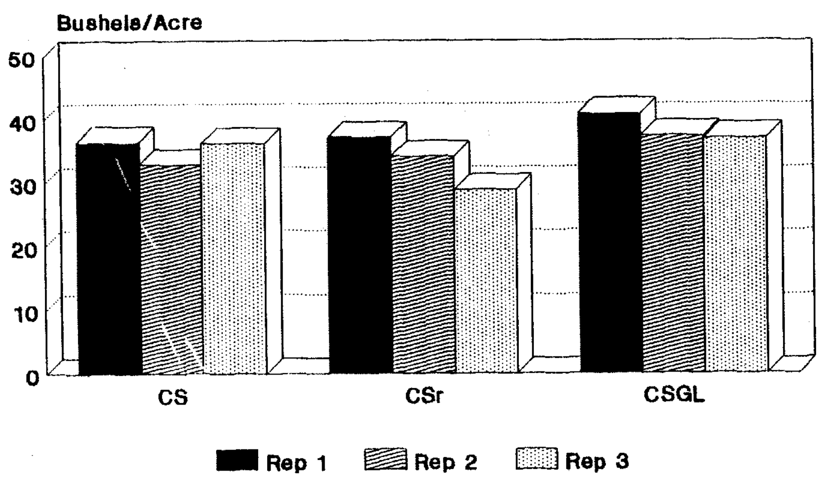
1995 Soybean Yield
Corn Soybean Rotation



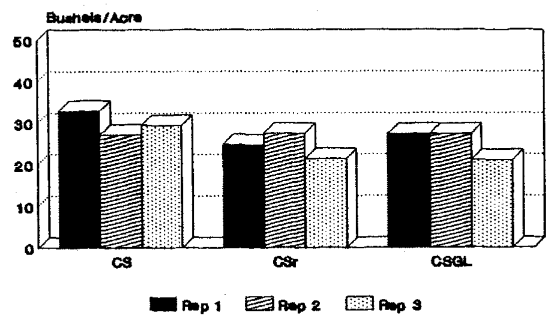
USDA Research Farm

1995 Soybean Yield
High Input



USDA Research Farm

1995 Soybean Yield
Integrated Input



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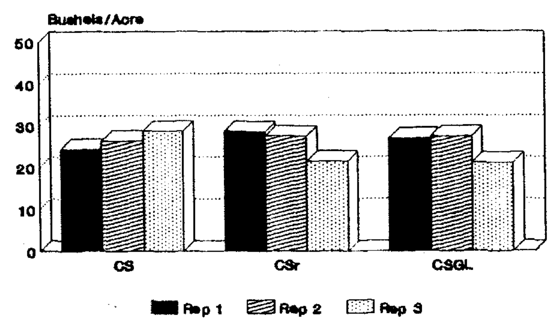
1995 Soybean Yield
Low Input (with Herb.)



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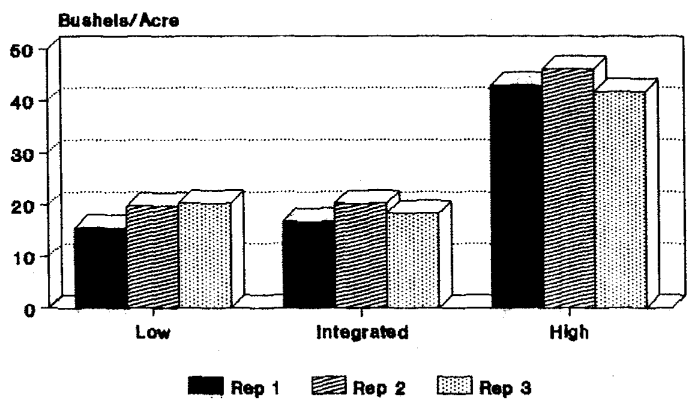
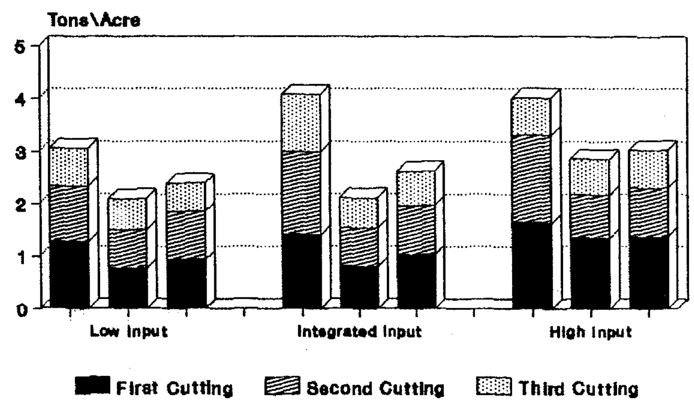
1995 Wheat Yield
4 Year Rotation



USDA Research Farm

1995 Legume Yield
4 Year Rotation



USDA Research Farm

MANAGEMENT OF CORN ROOTWORM ADULTS WITH SEMIOCHEMICAL INSECTICIDE-BAITS APPLIED WITH HIGH CLEARANCE SPRAYER METHODOLOGY - 1995

Laurence D. Chandler
USDA-ARS Northern Grain Insects Research Laboratory

Studies were initiated in 1994 to evaluate the effectiveness of high clearance sprayer application methods for improved placement of semiochemical insecticide-baits. Results indicated that all high clearance sprayer methods significantly reduced western and northern corn rootworm numbers compared to untreated control plots. Northern corn rootworm were somewhat more difficult to manage than western corn rootworms. Further studies were needed to provide additional data on optimal spray methodologies. The studies conducted in 1995 provided additional evidence of the effectiveness of high clearance sprayer technology for application of semiochemical insecticide-baits.

Methods and Materials

Field corn was planted in May 1995 in a 4 hectare field at the Eastern South Dakota Soil and Water Research Farm in Brookings County, SD. The field was divided into 24 plots each 26 rows (76 cm) wide and 60 meters long. Ten meter buffers were established between plots. Five sprayer application treatments and an untreated control were then arranged in a randomized block design with four replications. Treatments used were the same as the 1994 study :

1. Untreated control;
2. Insecticide-bait (19 L/ha); 1 nozzle/row over canopy;
3. Insecticide-bait (37 L/ha); 1 nozzle/row over canopy;
4. Insecticide-bait (19 L/ha); 2 nozzles on drops; every other row;
5. Insecticide-bait (37 L/ha); 2 nozzles on drops; every other row;
6. Insecticide-bait (37 L/ha); 2 nozzles on drops; every row;

Slam (MicroFlo Co. & BASF Corp.) was applied once (Julian day 221) during silking/tasseling at the rate of 561 g/ha of product in the above listed water volumes. Applications were made with a Modern Flow high clearance sprayer equipped with a 12 row boom and TX-4 hollow cone nozzles configured as indicated. Baits were applied at 0.9 kg/cm^2 and at variable speeds to accommodate the differing spray volumes. Drops extended 91 cm into the plant canopy and nozzles were pointed upward at 45 degree angles. The effectiveness of the insecticide-bait applications was determined by counting the number of live beetles observed on 50 plants/plot and the number of dead beetles in 74 X 97 cm metal trays placed on the ground (3/plot) under corn plants. These observations were made before insecticide-baits were applied and periodically afterwards. Means and standard errors were calculated for all data. Analysis of variance was conducted for data, from each observation date and means separated using Fishers LSD.

Results

Western and northern corn rootworm beetle numbers/plant were significantly reduced in all treatments following application of insecticide-baits (see accompanying figures). Beetle population densities after treatment remained low throughout the remainder of the study. Some resurgence in numbers of both western and northern corn rootworms were observed within 6 days following application. This is not totally unexpected in small plots. Northern corn rootworm numbers were higher in all plots and were more difficult to control. Dead beetle trays indicated that most beetles were killed within two days following insecticide-bait application. Beetles were found in dead beetle trays in substantial numbers 6 days after application. Dead northern corn rootworm females were still being recovered 14 days after treatment. No clear trends in preferred high clearance sprayer application methods were observed. All methods appeared to affect beetle populations in a similar manner.

Conclusion

As in 1994, all tested high clearance sprayer nozzle setups appeared to be quite effective in reducing total numbers of western and northern corn rootworm adults following insecticide-bait applications. Northern corn rootworms were again more difficult to control than western corn rootworms. No clear trends were noted in improved control using the 37 L/ha water volumes as compared with the 19 L/ha volumes. Drops within the corn canopy also did not appear to provide better beetle knockdown. In some instances drops were broken off because they hung on corn stalks and ears during the applications. For ease of application and sprayer setup use of nozzles over the top of the canopy appear to be the most favored mechanism for applying semiochemical insecticide-baits using high clearance sprayers. Water volumes did not appear to be a concern.

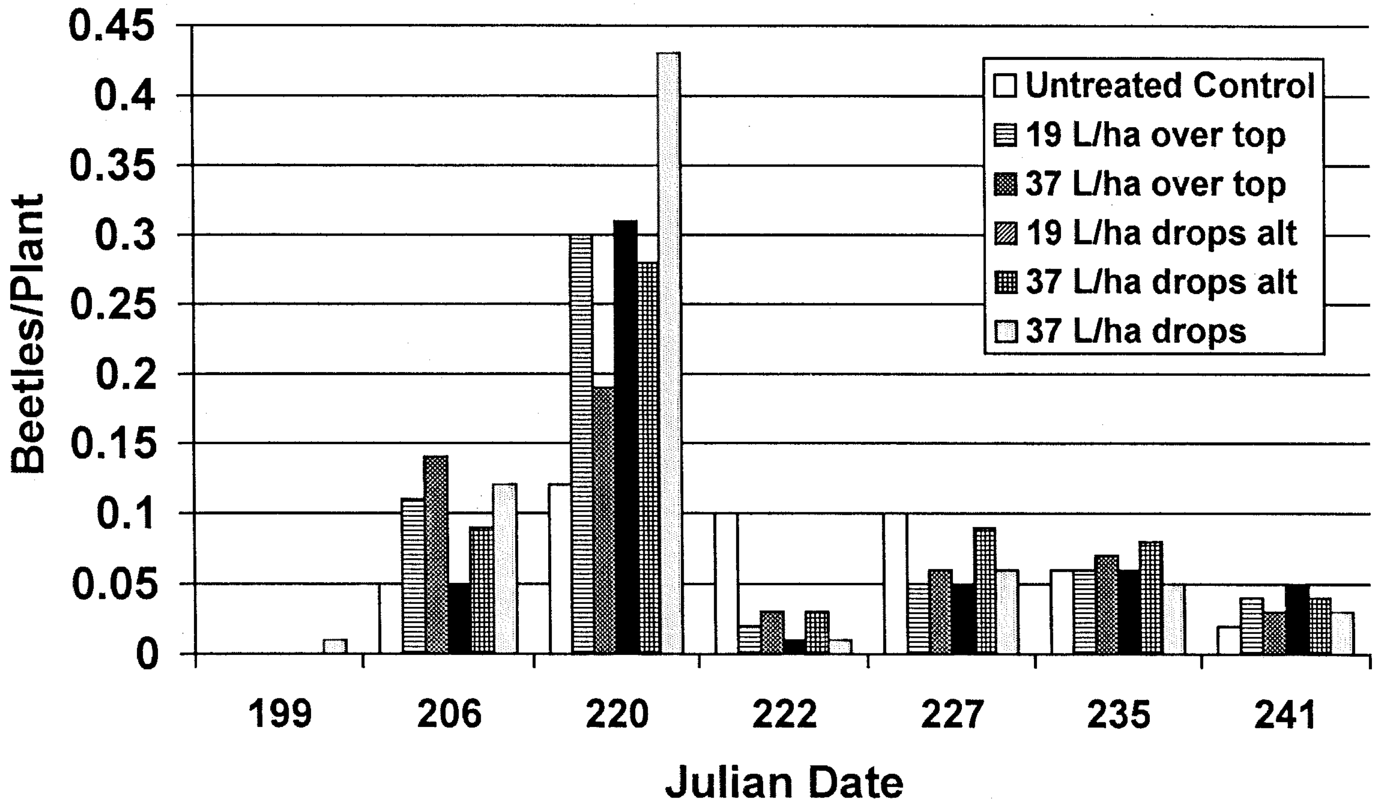
Acknowledgments

Denise Hovland, Deb Hartman, Bart Larson, Kyle Gross, and Shannon Larkin are acknowledged for their assistance with the study. Micro-Flo Co., in cooperation with BASF Corp., provided the insecticide-bait product.

Beetle Counts - Westerns

High Clearance Sprayer Methods

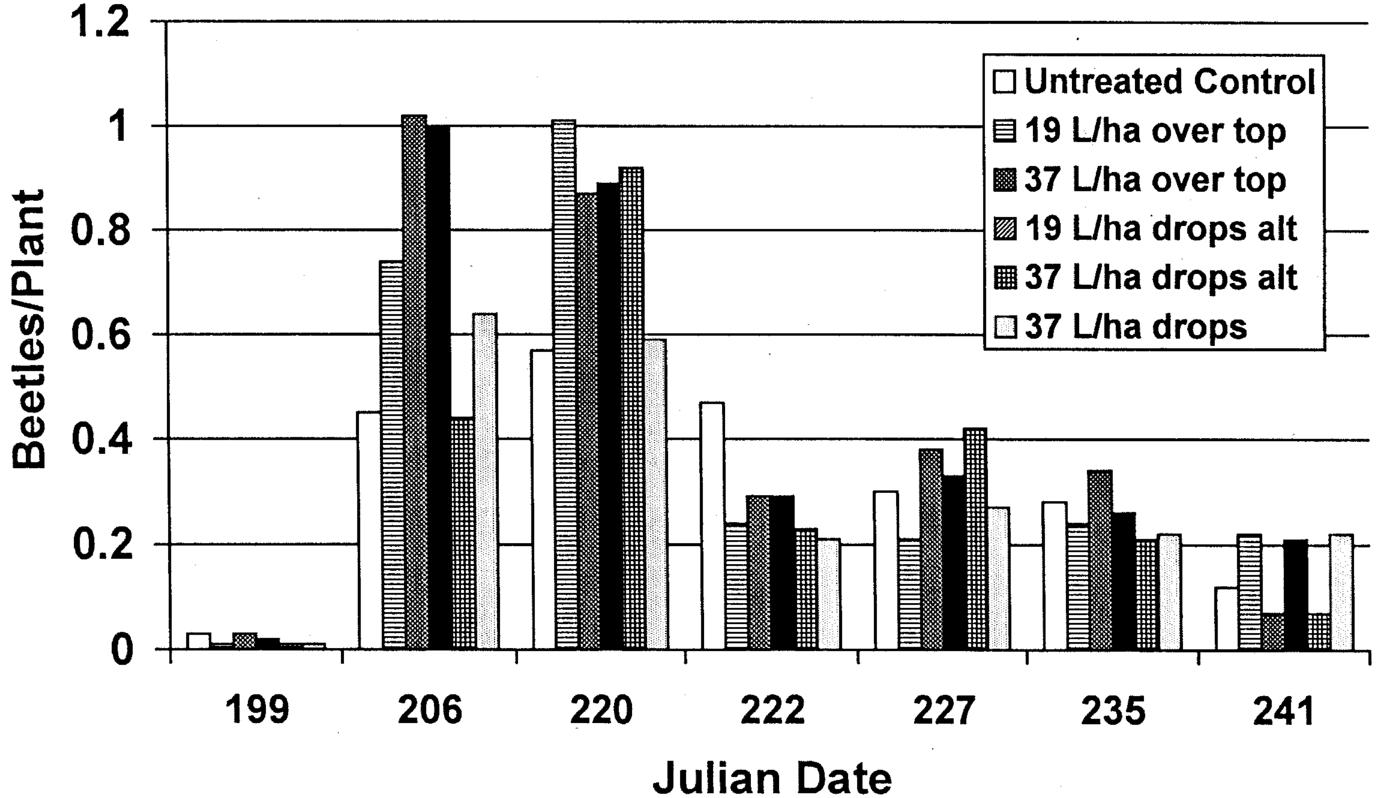
Sprayed on 221



Beetle Counts - Northerns

High Clearance Sprayer Methods

Sprayed on 221



EFFECT OF DEEP BANDING NITROGEN IN SMALL GRAINS: INFLUENCE ON YIELDS

D.J. Schneider and W.E. Riedell
USDA, ARS Northern Grain Insects Research Laboratory
R.H. Gelderman and J.R. Gerwing
Soil Testing Labs, Plant Science Department, South Dakota State University

Introduction

Our research objective at the Eastern South Dakota Soil and Water Research Farm was to determine the impact of deep banding nitrogen in no-till small grains. We wanted to compare deep banding to broadcasting and its impact on yields.

Materials and Methods

The Insect Lab purchased a John Deere 750 10' Small Grain Drill to which 8 colters and knives were added to the front of the planter. A tank and pump were attached for dispensing liquid fertilizer(UAN). The colters ran through the soil at a depth of 5".

Plots were laid out (10' wide by 65' long) x (5 treatments) x (4 replications) x (3 crops). Fertilizer products used were (28-0-0 liquid UAN)(10-34-0 liquid DAP)(46-0-0 dry)(18-46-0 dry).

Soil testing determined fertilizer needs to be 50 lbs N/acre, 35 lbs P/acre and 0 lbs K/acre. These were the rates we used. We selected Oats, Millet, and Winter Wheat as our small grain rotation.

Treatments	Nitrogen	Phosphorus
#1	28-0-0(DBL)	18-46-0(dry w/seed)
#2	28-0-0(DBL)	10-34-0(DBL)
#3	28-0-0(DBL)	18-46-0(BC dry)
#4	28-0-0(DBL)	none
#5	46-0-0(BC dry)	18-46-0(dry w/seed)

*DBL= Deep Banded Liquid
*BC = Broadcast

Results

We planted Settler Oats at 73 lbs/acre on 5/2/95. The oats were sprayed with Buctril on 6/12/95 at recommended rate. The oats developed a severe leaf rust during some extreme weather conditions (100 degree temperatures and 60 to 90% humidity) from 7/8/95 to 7/20/95, which occurred during the dough stage of development. Lodging also occurred from wind and rain and foxtail came on late as the oats were drying down. Harvest was done on 8/14/95 with a 1.5m(4.92ft) head on a plot combine.

1995 OATS
(bu/acre at 13%m)

	REP #1	REP #2	REP #3	REP #4	AVG
TRT #1	55.73	52.25	61.11	53.13	55.56±1.99
TRT #2	45.43	56.01	65.25	50.10	54.20±4.27
TRT #3	49.88	69.66	64.04	63.41	61.75±4.20
TRT #4	50.95	54.13	60.50	61.76	56.84±2.58
TRT #5	55.19	61.59	52.11	59.21	57.03±2.10
AVG	51.44	58.73	60.60	57.52	57.07

We planted Minsum White Proso Millet at 15 lbs/acre on 6/20/95. The millet was sprayed with 2,4-D Amine on 7/18/95 at recommended rate. The millet did well except for foxtail came on late as the millet dried down. Harvest was done on 8/14/95 with a 1.5m(4.92ft) head on a plot combine.

1995 MILLET
(bu/acre at 13%m)

	REP #1	REP #2	REP #3	REP #4	AVG
TRT #1	47.62	47.27	51.87	44.07	47.71±1.60
TRT #2	48.65	47.90	43.27	41.63	45.36±1.72
TRT #3	46.54	42.88	46.06	35.84	42.83±2.47
TRT #4	52.67	46.25	45.28	40.91	46.28±2.43
TRT #5	46.64	45.18	56.65	41.31	47.45±3.27
AVG	48.42	45.90	48.63	40.75	45.92

We planted Arapaho Winter Wheat at 92 lbs/acre on 9/14/95.

Conclusions

This was an establishment year for the rotations, treatments, and equipment. We think the rust, weather, and late season foxtail growth had an impact on our Oat crop performance. The Millet performed well except for late season foxtail growth. The effect of treatments showed no statistical significant difference over four replications for either crop. We had good average yields in both crops and are anxious for improved crop performance next year.

Acknowledgments

The authors would like to express their appreciation to B. Larson, M. Pravecek, J. Chlebecek, and S. Knutson for the technical assistance.

INFLUENCE OF MANAGEMENT TREATMENTS IN VARIOUS CROPS ON THE ABUNDANCE AND DIVERSITY OF INSECT POPULATIONS

R. W. Kieckhefer and D. A. Beck
USDA, ARS Northern Grain Insects Research Laboratory

Materials and Methods

Our research objective at the Eastern South Dakota Soil and Water Research Farm (ESDSWRF) is to determine the influence of management treatments (minimum input, integrated, and conventional) applied to the four-year rotation research plots on the abundance and diversity of insect populations in the aerial vegetation of these crops. Emphasis is on populations of the major economic insects of the crops. In this our sixth consecutive year of study on the ESDSWRF research plots, sampling continued to be carried out in wheat, alfalfa, and grass.

Insect populations were sampled by collecting two, 30-sweep, net subsamples from each of the nine 30.5 m x 30.5 m plots (three treatments - low, integrated and high input - each being replicated three times). A total of 18, 30-sweep, net subsamples were obtained from the crop type on a given sampling date. Insects in the samples were anesthetized using chloroform, transferred to containers, and frozen for later processing. When processing the samples, they were enumerated by taxon groups as outlined in Figure 1 (no dry weight biomass determinations made). The following taxa groupings were considered in all three crop types: common damsel bug, *Nabis americoferus*, common green lacewing, *Chrysoperla plorabunda*, and lady beetles (Coccinellidae). The developmental stage (adult versus larvae and/or nymph) was segregated for these taxa. The species of lady beetles were distinguished but for purposes of numerical data summary are lumped together. The wheat stem maggot, *Meromyza americana*, (adults only) was enumerated in both the wheat and grass. The potato leafhopper, *Empoasca fabae*, (adult and nymph combined) and alfalfa weevil, *Hypera postica*, (adult only) were only enumerated in alfalfa.

A "presence/absence method" was used in the field to obtain the data on aphids in wheat. Fifteen tillers (5 groups of 3 consecutive tillers) were examined per plot, and the data expressed as the percent of tillers infested with aphids. In alfalfa, aphid abundance was ascertained from the sweep net collection samples, however, a numerical rating scale was utilized instead of making an outright count as was done with all other taxa groups. Since the occurrence of aphids in grass was relatively low, an actual count of individuals was made.

On 10 July 1995 a tally of wheat stem maggot "damage" (i.e. white heads) was done in the wheat. A count of damaged/white heads was made using a 0.09 m^2 quadrat (50 readings

Figure 1. Comprehensive listing of insect taxa enumerated from sweep net sample collections in 3 crop types, ESDSWRF, 1995.

Taxon	Developm. Stage	CROP TYPE Wht.	Alf.	Grs.
(PHYLUM ARTHROPODA / CLASS HEXAPODA):				
Order HEMIPTERA				
Family Nabidae -	ad / ny [1]	X	X	X
common damsel bug, (*Nabis americoferus*)				
Order HOMOPTERA				
Family Aphididae - aphids or plantlice	ad + ny	X	X	X
Family Cicadellidae -	ad + ny		X	
potato leafhopper, (*Empoasca fabae*)				
Order NEUROPTERA				
Family Chrysopidae -	ad / la [1]	X	X	X
common green lacewing, (*Chrysoperla plorabunda*)				
Order COLEOPTERA				
Family Coccinellidae - lady beetles [2]	ad/la/pu [1]	X	X	X
Family Curculionidae -	ad		X	
alfalfa weevil, (*Hypera postica*)				
Order DIPTERA				
Family Chloropidae -	ad	X		X
wheat stem maggot, (*Meromyza americana*)				

[1] Differentiate between developmental stages: ad = adult
la = larvae
pu = pupae
ny = nymph

[2] Distinguish amongst the various lady beetle species

per plot); a count of the total number of wheat heads per quadrat (10 readings) was also made and the data expressed as the per cent of heads damaged. Information on various kinds of vegetative parameters were collected and records of meteorological conditions were taken each time a crop was sampled for insects, but rather than re-elaborate here, the reader is referred to the 1991 ESDSWRF Annual Report for specific details on how this was done.

The 1995 chronology/phenology of sampling in each of the crop types was as follows:

Wheat - 16 June (5-6 lf., late tillering), 28 June (anthesis), and, 25 July (soft dough) = total of 3 sampling dates [wheat planted 25 April / harvested 9 August]

Alfalfa - 12 June (bud), and, 12 July (< 10% flowering) = total of 2 sampling dates [1st cutting - 19 June, 2nd cutting - 21 July, 3rd cutting - 18 September]

Grass - 11 July (some Intermediate Wheatgrass still in anthesis, no inflorescence present on warm-season grasses) = only 1 sampling date

Results and Discussion

Enumeration of data obtained from our census of insect populations in several field crops at ESDSWRF during the 1995 growing season showed that again, as in several previous years, numbers of most beneficial and economic insect species fell below longer-term averages. We suppose this suppression of insect populations in crops to reflect retardation of insect development and inhibition of flight and movement caused by cooler and wetter than normal weather, especially during the early part of the growing season. The typical species fauna of lady beetles was present in wheat, alfalfa, and grass plots but adult numbers were comparatively low, with reproduction occurring only in wheat (just two lady species reproduced, and the number of their larvae were also low) (Table 1). Populations of other beneficial insects in wheat were also low by long-term standards, concomitant with low population density of aphid prey (Table 2). Population levels of economic insects monitored in wheat (Table 2) and alfalfa (Table 3) did not approach economic thresholds. The grass plots were nearly sterile of insect fauna in 1995 (Table 4). In general, no great differences were exhibited in the insect populations found amongst the three treatment/management input levels.

Table 1. Species of lady beetles (COLEOPTERA:Coccinellidae) encountered in 3 crop types during 1995 sampling on ESDSWRF research plots.

	PERCENT COMPOSITION					
	---WHEAT----		--ALFALFA---		---GRASS----	
	adult	larvae	adult	larvae	adult	larvae
Hippodamia convergens - "convergent"	12	-	3	-	100	-
H. tredecimpunctata tibialis - "13-spotted"	35	43	6	-	-	-
H. parenthesis - "parenthesis"	2	-	49	-	-	-
Coccinella septempunctata - "European sevenspotted"	2	-	26	-	-	-
Coleomegilla maculata - "pink & black"	47	57	15	-	-	-
Brachiacantha ursina	2	-	-	-	-	-
Psyllobora vigintimaculata	-	-	1	-	-	-
	100%	100%	100%	-	100%	-
(N =	51	7	88	-	1	-)
[# of sampling dates =	3		2		1]	

NOTE: No occurrences of lady beetle pupae.

Table 2. Summary of data from sweep net sample collections in ESDSWRF wheat plots, 1995.

TAXON	INPUT LEVEL Low	Integrated	High
Aphids (% of tillers infested)	4.4	2.2	2.2
Wheat Stem Maggot (% of heads damaged)	0.5	0.3	0.8
# of taxa (of 7 taxa groups possible, does not include aphids)	1.4	1.4	1.5
total numbers - for 7 taxa groups (does not include aphids)	2.4	2.6	3.5
# Damsel bugs - adult	1.3	1.0	1.1
- nymph	0.2	0.5	0.2
# Lacewings - adult	0.0	0.1	0.1
- larvae	0.0	0.2	0.1
# Lady beetles - adult (6 species)	0.7	0.6	1.6
- larvae (2 species)	0.0	0.1	0.3
Wheat stem maggot - adult	0.2	0.1	0.1

NOTE: Except for the aphid (% of tillers infested) and wheat stem maggot (% of heads damaged) data, these figures represent the mean value for a subsample consisting of 30 sweeps (two 30-sweep net subsamples per plot). Averaged over the three replicated treatment plots, and both subsamples, and 3 sampling dates.

Table 3. Summary of data from sweep net sample collections in ESDSWRF alfalfa plots, 1995.

TAXON	INPUT LEVEL		
	Low	Integrated	High
# Aphids	82.0	78.6	97.0
# of taxa (of 8 taxa groups possible, does not include aphids)	3.9	4.0	4.0
total numbers - for 8 taxa groups (does not include aphids)	25.6	31.7	32.3
# Damsel bugs - adult	3.5	4.5	4.6
- nymph	0.2	0.0	0.0
# Potato leafhopper - adults & nymphs	14.4	19.5	19.0
# Lacewings - adult	0.3	0.9	0.3
- larvae	0.0	0.0	0.2
# Lady beetles - adult (6 species)	2.8	1.8	2.7
- larvae (none)	0.0	0.0	0.0
# Alfalfa weevil - adult	4.4	5.0	5.5

NOTE: These figures represent the mean value for a subsample consisting of 30 sweeps (two 30-sweep net subsamples per plot). Averaged over the three replicated treatment plots, both subsamples, and 2 sampling dates.

Table 4. Summary of data from sweep net sample collections in ESDSWRF grass plots, 1995.

TAXON	Cool	Mix	Warm
Aphids (actual numbers)	0.3	0.0	0.0
# of taxa (of 7 taxa groups possible, does not include aphids)	0.5	0.5	0.3
total numbers - for 7 taxa groups (does not include aphids)	0.7	0.5	0.5
# Damsel bugs - adult	0.5	0.3	0.5
- nymph	0.0	0.0	0.0
# Lacewings - adult	0.2	0.0	0.0
- larvae	0.0	0.0	0.0
# Lady beetles - adult (1 species)	0.0	0.2	0.0
- larvae (none)	0.0	0.0	0.0
Wheat stem maggot - adult	0.0	0.0	0.0

NOTE: These figures represent the mean value for a subsample consisting of 30 sweeps (two 30-sweep net subsamples per plot). Averaged over the three replicated treatment plots, both subsamples, and 1 sampling date.

BARLEY YELLOW DWARF VIRUS AND BIRD CHERRY OAT APHID DAMAGE CAUSE SIGNIFICANT YIELD LOSS IN SPRING WHEAT

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Introduction

Barley yellow dwarf virus is probably the most widely distributed and most destructive virus disease of cereal grains. The disease affects over 100 species of plants in the grass family (Poaceae) including major crops such as barley, wheat, oats, sorghum, rye, triticale, maize, rice, and many wild grasses. Many of these crops, even when infected with the disease, do not exhibit obvious symptoms of the disease. Consequently, symptoms caused by barley yellow dwarf virus are often overlooked or associated with nutritional or other disorders. Tentative diagnosis of barley yellow dwarf is based upon the presence of aphid vectors and the occurrence of yellowed, stunted plants and leaf discoloration in shades of yellow, red, or purple (especially from tip to base and from margin to midrib). Definitive diagnosis requires serologic tests such as enzyme-linked immunosorbent assay (ELISA) and/or recovery and transmission of the virus by aphids (M.V. Wiese. 1987. Compendium of wheat diseases. APS Press, St. Paul, MN).

The long, mild autumn in 1994 allowed high population levels of bird cherry oat aphids to persist in the winter wheat crop in central South Dakota. These aphids are vectors of the barley yellow dwarf virus. Questions remain about the extent of yield loss in South Dakota caused by the BYDV outbreak of 1994 and its carryover into the 1995 winter wheat and spring wheat growing season. The objective of the studies reported here was to determine how aphid feeding and barley yellow dwarf virus affects spring wheat growth, development, and yield. Our goal is to understand the physiological mechanisms of yield loss caused by aphid feeding and barley yellow dwarf virus infection, and to use this understanding to help devise crop management methods to reduce the economic impact of these pests.

Materials and Methods

Field plots were established at the Eastern South Dakota Soil and Water Research Farm near Brookings, SD in the spring of 1995. Spring wheat (cv. Sharp) was planted on May 2, 1995 in 7.5 inch rows using a John Deere 750 small grain drill. Sixteen 1-meter cages were fitted over portions of the field, and root system (minirhizotron) observation tubes were installed at 30 degree angles under each cage. Treatments (with four replications) were a check, aphid damage only (300 aphid days, 1 aphid day is defined as one aphid feeding on a plant for a period of 24 hours), barley yellow dwarf virus only, and a combination of aphid damage and barley yellow dwarf virus. Treatments were applied when the crop was in the 1 to 2 leaf stage (May 15, 1995). To achieve the various treatments, the plants in eight cages were infested with viruliferous aphids. The aphids in half of those cages were killed with insecticide after 48 hours (BYDV only treatment), while the aphids in the other half of the cages were allowed to live until an 300 aphid day level was attained (combination). Plants in four cages were infested with nonviruliferous aphids, which were left on for a period of 300 aphid days (aphid damage only).

When the plants in the check treatment reached the flowering (anthesis) stage of development (June 28, 1995), several crop characteristics were measured. Crop development was estimated for all treatments using the Decimal Code method (RKM Hay and AJ Walker, 1989. Introduction to the physiology of crop yield, John Wiley and Sons, Inc). Crop growth and development was measured by sampling plants and measuring: the number and length of tillers, the dry weight of stems and leaves, and the length of roots observed using the minirhizotron system. Crop yield components measured included the number of spikelets per head, the number of heads and seeds per foot of row, the average seed weight, and the weight of grain per foot of row.

Results

When compared with the check treatment at the time of anthesis (June 28), feeding damage caused by the bird cherry oat aphid resulted in delayed crop development, less stem and leaf dry weight, reduced tiller number and length, and very little difference in root length (Table 1). Barley yellow dwarf virus infection caused similar reductions in these variables, except that the root length was dramatically less than the check or aphid damage alone treatments. The combination treatment consisting of aphid feeding damage plus barley yellow dwarf infection caused slightly greater reductions in these variables than seen in the barley yellow dwarf infection alone treatment.

Yield component measurements (Table 2) reveal that feeding damage by bird cherry oat aphid slightly reduced the number of heads and the total number of seeds per foot of row when compared with the check treatment. Yield was reduced by about 25 % in the aphid damage only treatment. Barley yellow dwarf virus infection dramatically reduced all yield components measured resulting in about a 75 % yield loss when compared with the check treatment. The combination treatment of aphid feeding damage plus barley yellow dwarf infection also caused slightly greater reductions in these yield components than seen in the barley yellow dwarf infection alone treatment.

Discussion

Among the more prevalent cereal aphid species in the Northern Plains are the greenbug, the English grain aphid, and the bird cherry oat aphid. Seedling spring wheat may be infested shortly after emergence by any and all of these species of cereal aphids. Numerous reports have been published on crop injury and yield reductions caused by aphid feeding on oats and wheat. The extent of crop injury caused by these pests depends on the extent of the aphid infestation, its timing during the growing season, and whether the aphids are vectors of barley yellow dwarf virus (BYDV). The results of the present study suggest that feeding damage caused by the bird cherry oat aphid alone can reduce yield by nearly 25 percent.

Low populations of cereal aphids feeding on winter wheat over an extended period of time in the fall can cause significant yield reductions when the crop is harvested the following summer. The threshold for significant yield loss under these environmental conditions is 10 aphids per plant for the bird cherry oat aphid and the Russian wheat aphid and 15 aphids per plant for the greenbug. Yield losses caused by any aphid species are in the range of 35 to 40 percent at 15 aphids per plant. Although the visible injury to plants caused by the feeding of the greenbug and Russian wheat aphid can be striking, the bird cherry oat aphid is as damaging to yield as the other two species.

One of the most important effects of cereal aphid infestation on cereals is in transmitting BYDV. This is because BYDV causes extensive yield loss to both oat and winter wheat crops. In the present study, BYDV caused a 63 % reduction in the number of grains per foot of row, a 75 % reduction in yield, and a 27 percent reduction in average seed weight. In oats, BYDV can cause a 11-60 percent reduction in number of grains per head, 30-70 percent reduction in head weight, and 1-10 percent reduction in 100 kernel weight. BYDV caused similar reduction in these yield components of winter wheat. Cultivars sensitive to BYDV may show significant yield loss when the disease infection occurs at any stage of plant development, but that infection at the 3 leaf stage was the most damaging (averaging 40 to 50 percent yield reduction).

Cereal plant mineral nutrition can also play a role in plant tolerance to feeding of cereal aphids. When wheat plants that were deficient in macronutrients are infested with greenbugs, yield loss was 39 percent, 23 percent, 24 percent, and 19 percent for nitrogen, phosphorus, potassium, or magnesium deficiency, respectively. Nitrogen fertilizer applications can reduce yield loss in aphid-damaged plants, supporting the contention that crop management practices that promote shoot and root growth, such as supplemental nitrogen fertilizer applications at planting time, could play important roles in improving plant tolerance to aphid damage.

Table 1. Effect of aphid (bird cherry oat aphid) infestation, barley yellow dwarf virus (BYDV) infection, or a combination of aphid plus BYDV damage on wheat growth and development.

Treatment	Growth Stage[1]	Stem Dry Weight[2]	Leaf Dry Weight[2]	Tiller Number	Tiller Length	Root Length[3]
Check	60	9.2	8.8	12	68	1431
Aphid	52	3.9	5.2	5	58	1579
BYDV	49	2.7	4.3	5	52	421
Aphid + BYDV	48	2.0	3.2	3	48	508

[1] Growth stage using Decimal Code for description of cereal crop development: 60 = anthesis, 50 = ear emergence from leaf roll, 40 = ear in "boot".
[2] Units are grams per plant.
[3] Units are indexed values from minirhizotron video image analysis.

Table 2. Effect of aphid (bird cherry oat aphid) infestation, barley yellow dwarf virus (BYDV) infection, or a combination of aphid plus BYDV damage, on wheat yield components.

Treatment	Number of spikelets/head	Number of heads	Number of seeds	Average seed weight[1] (mg)	Yield[1] (g)
Check	14	32	737	2.6	19
Aphid	13	26	595	2.4	14
BYDV	12	17	269	1.9	5
Aphid + BYDV	10	16	202	1.8	4

[1] All data expressed on a "per foot of row" basis.

1995 CORN ROOTWORM EMERGENCE AND EGG COUNTS IN CONTINUOUS CORN

David Woodson
USDA-ARS Northern Grain Insects Research Laboratory

There are a wide variety of management options available for corn production. Tillage may be conventional, ridge till, minimum till or no till. Crop rotations in this region tend to be none, i.e. continuous corn, simple corn soybean rotation, or corn soybean small grain rotation. Insecticide use is quite variable, too. The purpose of this study is to examine how some of these different practices affect rootworm population dynamics. Plots were established with three treatments: 1) low input plots were disked and had no chemical inputs; 2) integrated input plots were chisel plowed and had herbicides applied; 3) high input plots were moldboard plowed and had herbicides and insecticides applied.

All plots were sampled for corn rootworm eggs in the spring (May) and Fall (September) to estimate the initial and end of season rootworm egg density. Four soil samples per plot were taken, the eggs washed from the soil, and the eggs were identified to specie and counted. Adult rootworm emergence was monitored from the middle of July until the September. Four emergence traps per plot were placed in the corn rows over 3 cut off corn plants in July. These traps were checked twice weekly for beetles. Beetles brought back to the lab, were identified to specie, sexed and counted.

Poor spring weather prevented many of these eggs and larvae from surviving to adulthood. As in previous years the northern corn rootworm dominated the system dynamics. Western corn rootworms have almost disappeared from the plots on the farm. Several factors may account for this including competition with northerns and the unusually wet field conditions that have predominated for the past 4 years. Fall egg counts showed rootworm eggs to be 3 or 4 times greater in the low and integrated plots when compared to the high input plots. This was likely due to the large numbers of wild sunflowers in the low and integrated plots. Northern corn rootworm adults feed on the pollen of these plants therefore, having these weeds in the corn plots setup a situation where heavy egg laying could occur.

Plot Specifics:

Mean spring eggs per sample were 14.4 and 3.4 for the northern and western corn rootworm in the high input plots (Fig 1). Beetle emergence (Fig 2) was reduced from the numbers seen in 1994. Only 35 northerns and 2 westerns were captured over the summer in the high input plots. In fall egg counts (Fig 3) northern corn rootworms averaged 13.8 eggs per sample and westerns averaged 1.3 eggs per sample.

Mean spring eggs per sample were 10.2 and 0.8 for the northern and western corn rootworm in the integrated input plots (Fig 1). Beetle emergence (Fig 2) was reduced from the numbers seen in 1994. Only 29 northerns and 1 westerns were captured over the summer in the integrated input plots. In fall egg counts (Fig 3) northern corn rootworms averaged 66.8 eggs per sample and westerns averaged 0.1 eggs per sample.

Mean spring eggs per sample were 8.7 and 6.0 for the northern and western corn rootworm in the low input plots (Fig 1). Beetle emergence (Fig 2) was reduced from the numbers seen in 1994. Only 32 northerns and 5 westerns were captured over the summer in the low input plots. In fall egg counts (Fig 3) northern corn rootworms averaged 41 eggs per sample and westerns averaged 0.3 eggs per sample.

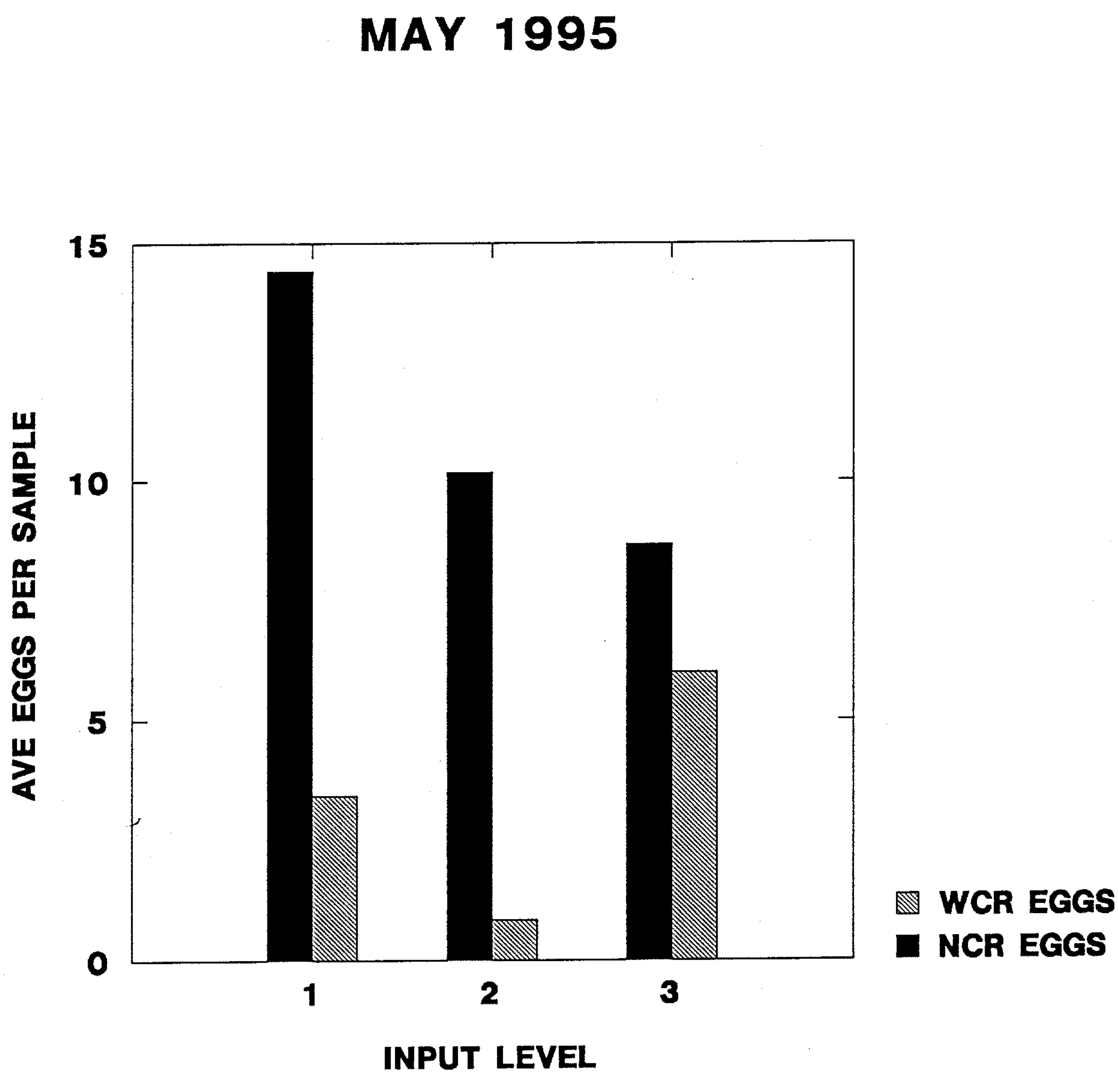
MAY 1995
15
10
5
0
AVE EGGS PER SAMPLE
1
2
3
INPUT LEVEL
WCR EGGS
NCR EGGS

FIG 1.

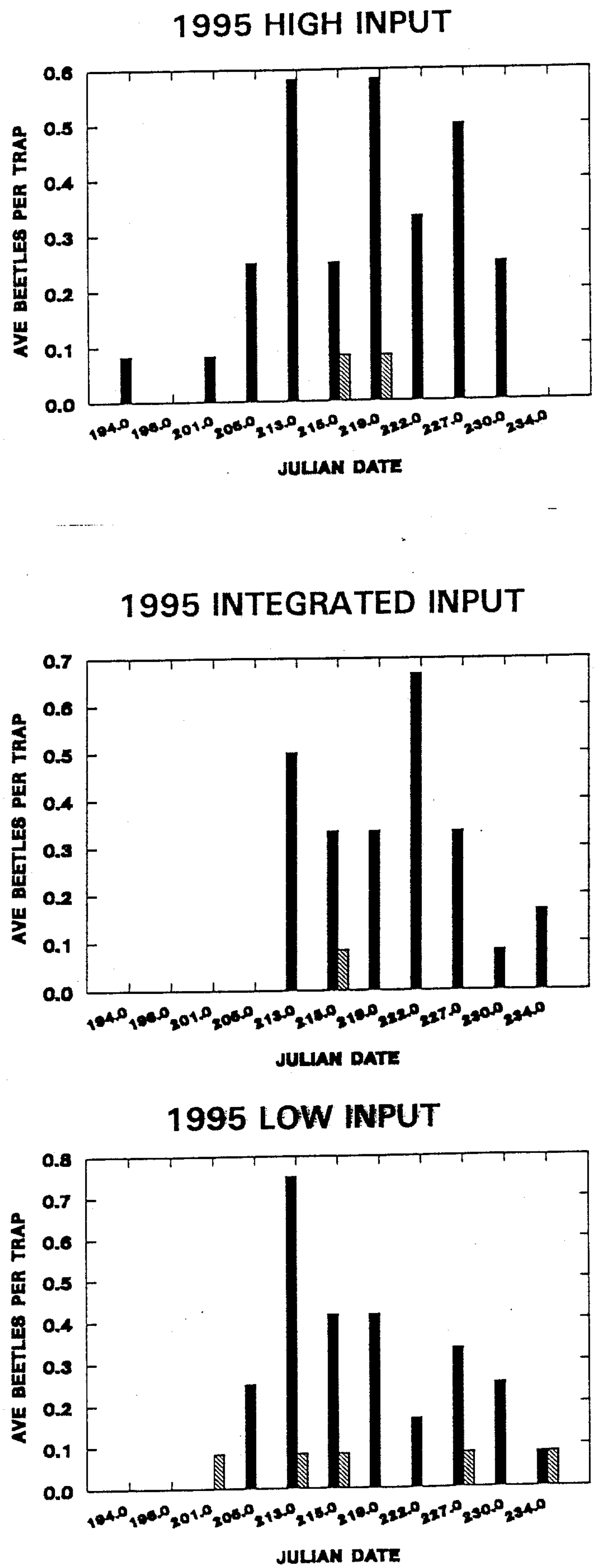
1995 HIGH INPUT
AVE BEETLES PER TRAP
0.0 0.1 0.2 0.3 0.4 0.5 0.6
194.0 198.0 201.0 205.0 213.0 215.0 219.0 222.0 227.0 230.0 234.0
JULIAN DATE
1995 INTEGRATED INPUT
AVE BEETLES PER TRAP
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
194.0 198.0 201.0 205.0 213.0 215.0 219.0 222.0 227.0 230.0 234.0
JULIAN DATE
1995 LOW INPUT
AVE BEETLES PER TRAP
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
194.0 198.0 201.0 205.0 213.0 215.0 219.0 222.0 227.0 230.0 234.0
JULIAN DATE

FIG. 2

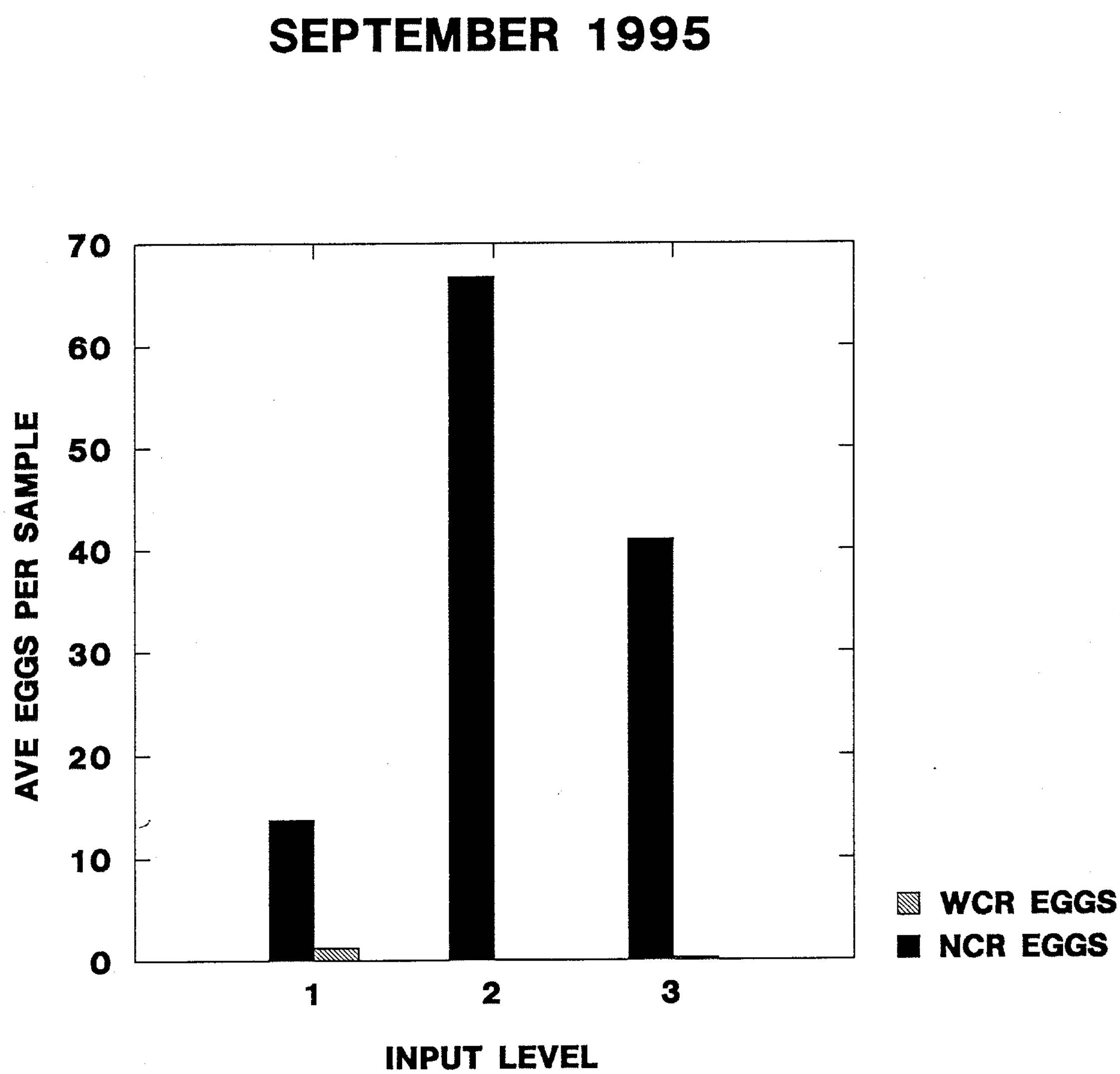
SEPTEMBER 1995
AVE EGGS PER SAMPLE
70
60
50
40
30
20
10
0
1
2
3
INPUT LEVEL
WCR EGGS
NCR EGGS

FIG. 3

AGRONOMIC PRINCIPLES DEMONSTRATED BY THE ROTATION-INPUT PLOTS AT THE EASTERN SOUTH DAKOTA SOIL AND WATER RESEARCH FARM

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Introduction

> "Wherever continuous corn growing has been practiced for any considerable length of time, yields have invariably gone down and become unprofitable. It has also become evident that short rotations of corn and other grain crops are not satisfactory. There is something else lacking. Other classes of crops must be introduced."

> "There is a practical advantage to be gained by the succeeding crop from replacing oats and possibly corn by soybeans, especially when clover is not included in the rotation. Since the oat crop is the one which could most easily be spared from rotations in many parts of the country, these data are rather encouraging."

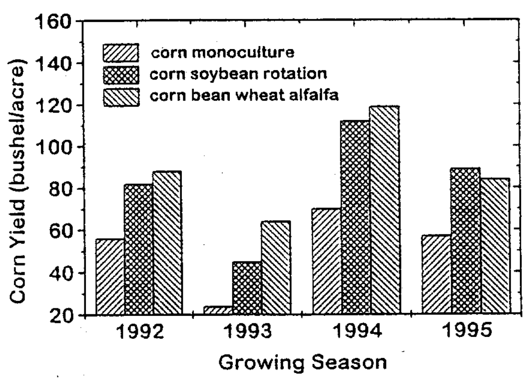
> "Apparently the determining factor in crop production over much of the trans-Missouri River region is usually moisture. The crop or tillage that leaves the most moisture in the soil is likely to be the one that is followed by the largest crops."

These words, written in 1927, explain a consensus that was formed among agricultural researchers early this century: that the rich prairie soils were being mined of their inherent productivity by monoculture, that crop rotation with legumes would restore some of the lost productivity, and that in dry areas (because of potentially limited plant growth) legumes would have less impact in restoring the productivity of soils than in humid areas. A 1956 investigation of crop rotations in southeast South Dakota, concluded that "a green manure catch crop of legumes seeded in small grain and plowed down the following spring for corn is more profitable than stand-over legumes used for hay at usual growing and harvesting costs." The catch crop in these studies was sweet clover, and the stand-over legume was alfalfa or red clover.

The most prevalent rotation currently used in the southeast region of South Dakota is corn/soybean, while in northeast South Dakota a barley or spring wheat/soybean rotation is popular. Farmers have realized the value of crop rotations with legumes as an important component of those rotations. In the 1992 crop season, South Dakota farmers applied an average 64 kg/ha actual N to corn, while spring wheat received 42 kg/ha actual N. Could these fertilizer applications be reduced if more complex rotations using more legumes were adapted? What is the potential impact of conservation tillage and no-till on these relationships? How will crop rotations affect weed and insect populations? And finally, what would the farmers in eastern South Dakota and western Minnesota stand to gain if they adapted a more complex rotation? The rotation-input plots at the Eastern South Dakota Soil and Water Research Farm were designed to address some of these questions. Some of the agronomic principles demonstrated by this work are:

Principle 1: Corn grown under crop rotation, which improves soil fertility and breaks insect and disease cycles, is an important component in increasing yield of corn crops.

Corn grain yields obtained in the rotation-input plots over a four year period are shown in Figure 1 (left) and Figure 2 (right).



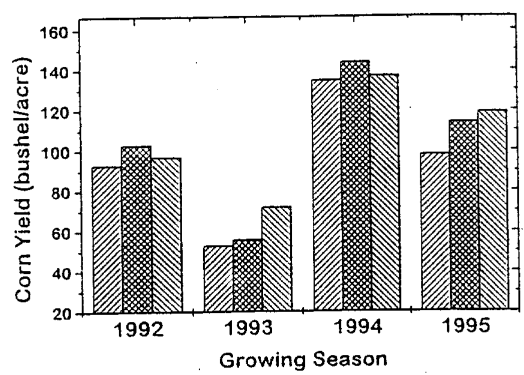
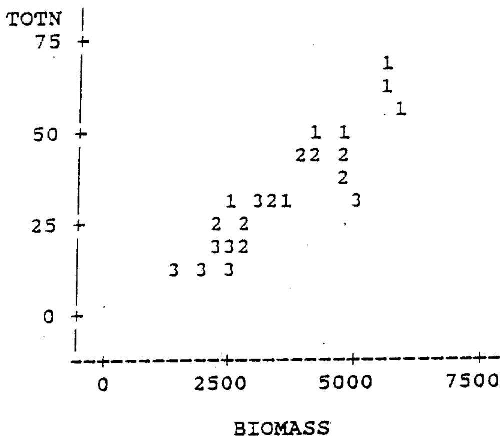


Figure 1 is for plots that received 47 lbs of 13-33-13 granular starter fertilizer (2x2 band) at planting plus enough 46-0-0 side dress incorporated with second cultivation to produce 85 bushels per acre yield. Plots were cultivated twice, and herbicide applied only upon recommendation.

Figure 2 is for plots that received 99 lbs of 13-33-13 granular starter fertilizer (2x2 band) at planting plus enough 46-0-0 side dress incorporated with second cultivation to produce 130 bushels per acre yield. Pre-emergence Lasso 4L (3 qt) and Bladex (1.3 lbs) and post-emergence Buctril (2 pt) were used for weed control. Plots were cultivated twice.

Principle 2: The total amount of nitrogen taken up by the corn crop increases in a linear fashion as the amount of corn crop biomass at the tassel stage of development increases.

Figure 3 (left) and Figure 4 (right) show the corn crop nitrogen content (TOTN) at the tassel stage of development plotted as a function of the crop biomass at the tassel stage of development (both TOTN and BIOMASS units are lbs per acre).



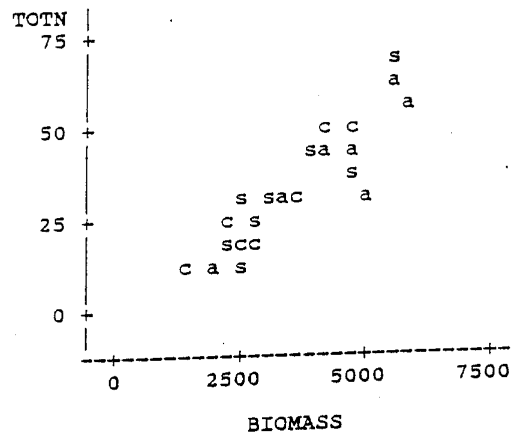
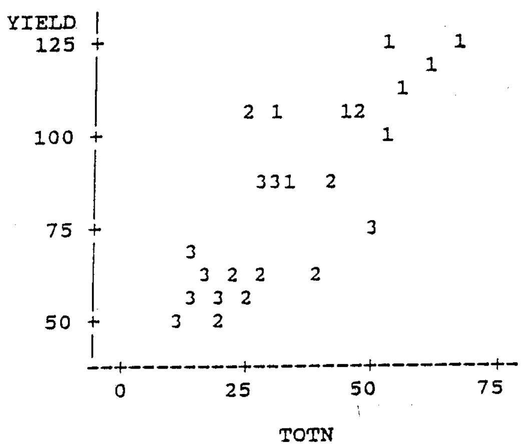


Figure 3 shows the impact of input level (1=high input as described in Fig. 2; 2=managed input as described in Fig. 1; and 3=no chemical input) on biomass-crop nitrogen relationships. Generally speaking, the high input treatments produced the greatest crop biomass and highest levels of nitrogen in the field at tassel stage of development.

Figure 4 shows the impact of previous crop (c=corn; s=soybean; a=alfalfa) on biomass-crop nitrogen relationships. Generally speaking, previous crop treatments of soybean or alfalfa produced the greatest crop biomass and highest levels of nitrogen in the field at tassel stage of development.

Principle 3: Grain yield production of the corn crop increases in a linear fashion as the amount of nitrogen contained by the corn crop at the tassel stage of development increases.

Figure 5 (left) and Figure 6 (right) show grain yield (in bushels per acre) plotted as a function of the corn crop nitrogen content (TOTN) at the tassel stage of development (TOTN units are lbs per acre).



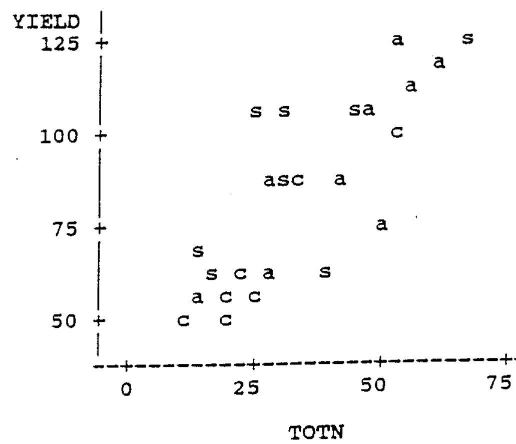


Figure 5 shows the impact of input level (1=high input as described in Fig. 2; 2=managed input as described in Fig. 1; and 3=no chemical input) on yield-crop nitrogen relationships. Generally speaking, the high input treatments produced the highest levels of nitrogen in the crop at tassel stage of development and greatest yield.

Figure 6 shows the impact of previous crop (c=corn; s=soybean; a=alfalfa) on yield-crop nitrogen relationships. Generally speaking, previous crop treatments of soybean or alfalfa produced the highest levels of nitrogen in the crop at tassel stage of development and greatest yield.

Discussion

One of the most important components of growing crops in rotation is increased crop yields over time. Long-term experiments report average yield increases of 10 to 17 % when corn is grown in rotation rather than monoculture. Work done in Canada demonstrated a consistent, but small yield advantage (1.5 to 9 %) to planting corn in rotation rather than continuously. These authors found that including legumes as hay or as an under-seeded crop in the rotation may be more beneficial than simply including barley, winter wheat, or soybean in rotations involving corn. Rotational effects on soybean yield tend to be less than those seen in corn although soybeans grown in continuous monoculture produce lower seed yield, less dry matter, and smaller seeds than plants grown in rotation. Grain sorghum grown in rotation also produces higher grain yield than when grown in monoculture. Sorghum in a 2-year sorghum/soybean rotation produced sustained high yields without additions of N fertilizer.

The components of crop rotations that improve crop growth and yields obviously center on improved nitrogen fertility of soil. However, Copeland and Crookston (1992. Agron. J. 84:503-509) have concluded that a general improvement in root function, due to crop rotation alone, also plays an important role in these improved crop yields. These authors suggested that further research was needed to determine the causal effects and agents responsible for this improved root function. Although the rate and pattern of root growth vary with soil physical, chemical, and biological properties, plant genetic potential, and climate, the effect of crop rotation has not been widely studied. An understanding of below-ground crop and soil relationships is needed before any explanation of crop rotation effects on crop yield could be achieved.

Instrumentation and techniques needed for root system/crop rotations studies have been developed at the Northern Grain Insects Research Lab. Additionally, a minirhizotron video tape system plus associated image analysis software has recently been acquired. These root system observation and characterization capabilities plus detailed characterization of the soil physical and chemical properties, superimposed on long-term rotation/input plots at the Eastern South Dakota Soil and Water Research Farm, would allow excellent progress to be made towards understanding the scientific basis of improved crop yield seen under crop rotations.